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TITLE: PRODUCTION OF STEEL TUBE FOR AIR BAG, HAVING HIGH STRENGTH AND HIGH TOUGHNESS

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INVENTOR-INFORMATION:

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ABSTRACT:

PROBLEM TO BE SOLVED: To produce a seamless steel tube for an accumulator for air bag system, excellent in workability and weldability and having high strength and high toughness.

SOLUTION: A steel, having a composition consisting of 0.01-<0.20% C, ≤0.50% Si, 0.30-2.00% Mn, ≤0.020% P, ≤0.020% S, ≤0.10% Al, and the balance Fe with inevitable impurities, is subjected to hot tube making at ≥750°C final finishing temp. The resultant steel tube is used in this state or used in a state after subjected, after hot tube making, to stress relief annealing, normalizing, annealing, and hardening or is used after subjected to quench-and-temper treatment. By this method, the seamless steel tube, excellent in workability and weldability and having high strength and high toughness, can be produced.

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(54)【発明の名称】　高強度高靭性エアーバッグ用鋼管の製造方法

(57)【要約】
【課題】　エアーバッグシステムのアキュムレータ用の加工性と溶接性に優れ、かつ高強度、高靭性継目無鋼管を製造する。
【解決手段】　Ｃ：０．０１～０．２０％未満、Ｓｉ：０．５０％以下、Ｍｎ：０．３０％～２．００％、Ｐ：０．０２０％以下、Ｓ：０．０２０％以下、Ａｌ：０．１０％以下を含有し、残部がＦｅおよび不可避的不純物からなる鋼を最終仕上温度が７５０℃以上となるよう熱間製管したまま、あるいは熱間製管後応力除去焼鈍、焼ならし、焼なまし、焼入れまま、または焼入れ焼戻し処理を施すことによって、加工性と溶接性に優れ、かつ高強度、高靭性継目無鋼管を製造できる。

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【特許請求の範囲】

【請求項1】　C：0．05%以上0．15%未満、Si：0．50%以下、Mn：0．30%～2．00%、P：0．020%以下、S：0．020%以下、Al：0．10%以下を含有し、残部がFeおよび不可避的不純物からなる鋼を、最終仕上温度が750℃以上となるよう熱間製管を行うことを特徴とする高強度高靭性エアーバッグ用鋼管の製造方法。

【請求項2】　C：0．01%～0．20%、Si：0．50%以下、Mn：0．30%～2．00%、P：0．020%以下、S：0．020%以下、Al：0．10%以下を含有し、残部がFeおよび不可避的不純物からなる鋼を、最終仕上温度が750℃以上となるよう熱間製管を行うことを特徴とする高強度高靭性エアーバッグ用鋼管の製造方法。

【請求項3】　C：0．05%以上0．15%未満、Si：0．50%以下、Mn：0．30%～2．00%、P：0．020%以下、S：0．020%以下、Al：0．10%以下を含み、Mo：0．50%以下、V：0．10%以下、Ni：0．50%以下、Cr：1．00%以下、Cu：0．50%以下、Ti：0．10%以下、Nb：0．10%以下、B：0．005%以下のうち1種以上を含有し、残部がFeおよび不可避的不純物からなる鋼を、最終仕上温度が750℃以上となるよう熱間製管を行うことを特徴とする高強度高靭性エアーバッグ用鋼管の製造方法。

【請求項4】　C：0．01%～0．20%、Si：0．50%以下、Mn：0．30%～2．00%、P：0．020%以下、S：0．020%以下、Al：0．10%以下を含み、Mo：0．50%以下、V：0．10%以下、Ni：0．50%以下、Cr：1．00%以下、Cu：0．50%以下、Ti：0．10%以下、Nb：0．10%以下、B：0．005%以下のうち1種以上を含有し、残部がFeおよび不可避的不純物からなる鋼を、最終仕上温度が750℃以上となるよう熱間製管を行うことを特徴とする高強度高靭性エアーバッグ用鋼管の製造方法。

【請求項5】　C：0．05%以上0．15%未満、Si：0．50%以下、Mn：0．30%～2．00%、P：0．020%以下、S：0．020%以下、Al：0．10%以下を含有し、残部がFeおよび不可避的不純物からなる鋼を熱間製管後、応力除去焼鈍、焼なまし、焼ならし、焼入れのままあるいは焼入れ焼戻し処理を施すことを特徴とする高強度高靭性エアーバッグ用鋼管の製造方法。

【請求項6】　C：0．01%～0．20%、Si：0．50%以下、Mn：0．30%～2．00%、P：0．020%以下、S：0．020%以下、Al：0．10%以下を含有し、残部がFeおよび不可避的不純物からなる鋼を熱間製管後、応力除去焼鈍、焼なまし、焼ならし、焼入れのままあるいは焼入れ焼戻し処理を施すことを特徴とする高強度高靭性エアーバッグ用鋼管の製造方法。

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【請求項7】　C：0．05%以上0．15%未満、Si：0．50%以下、Mn：0．30%～2．00%、P：0．020%以下、S：0．020%以下、Al：0．10%以下を含み、Mo：0．50%以下、V：0．10%以下、Ni：0．50%以下、Cr：1．00%以下、Cu：0．50%以下、Ti：0．10%以下、Nb：0．10%以下、B：0．005%以下のうち1種以上を含有し、残部がFeおよび不可避的不純物からなる鋼を熱間製管後、応力除去焼鈍、焼なまし、焼ならし、焼入れのままあるいは焼入れ焼戻し処理を施すことを特徴とする高強度高靭性エアーバッグ用鋼管の製造方法。

【請求項8】　C：0．01%～0．20%、Si：0．50%以下、Mn：0．30%～2．00%、P：0．020%以下、S：0．020%以下、Al：0．10%以下を含み、Mo：0．50%以下、V：0．10%以下、Ni：0．50%以下、Cr：1．00%以下、Cu：0．50%以下、Ti：0．10%以下、Nb：0．10%以下、B：0．005%以下のうち1種以上を含有し、残部がFeおよび不可避的不純物からなる鋼を熱間製管後、応力除去焼鈍、焼なまし、焼ならし、焼入れのままあるいは焼入れ焼戻し処理を施すことを特徴とする高強度高靭性エアーバッグ用鋼管の製造方法。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、加工性と溶接性に優れ、かつ590N／mm²以上の高強度、高靭性が要求されるエアーバッグ用部品に適した高強度高靭性鋼管の製造方法に関する。

【0002】

【従来の技術】近年、自動車産業においては、安全性を追求した装置の導入が積極的に進められているが、その中でも衝突時に乗員がハンドルやインストルメントパネルなどに衝突する前に、それらと乗員との間にガス等でエアーバッグを展開させ、乗員の運動エネルギーを吸収して傷害軽減を図るエアーバッグシステムが開発搭載されるに至っている。

【0003】エアーバッグシステムとしては、従来爆発性薬品を使用する方式が採用されてきたが、高価であり、かつ環境問題、リサイクル問題から近年アルゴンガス充填鋼管製アキュムレータを使用するシステムが開発された。アルゴンガス等のアキュムレータに用いる鋼管は、衝突時にエアーバッグ内に吹出す不活性ガス等を常時300kgf／cm²に保ったうえで、衝突時少量の火薬点火時のガスを付加し、一気にガスを噴出させるので、極めて短時間に大きな歪速度で応力が付加されるた

め、従来の圧力シリンダーやラインパイプのような単なる構造物と異なり、高強度、高靭性と共に加工性ならびに溶接性が要求される。

【0004】

【発明が解決しようとする課題】前記アキュムレータ用の新規分野に用いる鋼管は、高強度、高靭性と共に加工性ならびに溶接性が要求されるため、従来の冷間引抜き加工と応力除去焼鈍の組合せでは、高強度化により靭性が低下し、上記要求を満足することはできない。

【0005】本発明の目的は、従来技術の全くない新分野として、加工性と溶接性に優れ、かつ高強度、高靭性が要求されるエアーバッグ用部品に適した高強度高靭性エアーバッグ用鋼管の製造方法を提供することにある。

【0006】

【課題を解決するための手段】本発明者らは、上記目的を達成すべく鋭意試験研究を重ねた。その結果、所定の成分の鋼を最終仕上温度が７５０℃以上となるように熱間製管するか、あるいは所定の成分の鋼を熱間製管後、応力除去焼鈍、焼なまし、焼ならし、焼入れのままたは焼入れ焼戻し処理を施すことによって、加工性と溶接性に優れ、かつ高強度、高靭性鋼管が得られることを究明し、本発明に到達した。

【0007】本発明の請求項１の高強度高靭性エアーバッグ用鋼管の製造方法は、Ｃ：０．０５%以上０．１５%未満、Ｓｉ：０．５０%以下、Ｍｎ：０．３０%～２．００%、Ｐ：０．０２０%以下、Ｓ：０．０２０%以下、Ａｌ：０．１０%以下を含有し、残部がＦｅおよび不可避的不純物からなる鋼を、最終仕上温度が７５０℃以上となるよう熱間製管を行うこととしている。このように、鋼中の化学成分を上記成分組成に限定することによって、エアーバッグのアキュムレータ用として十分な強度、靭性と高加工性、溶接性を得ることができる。また、上記鋼を最終仕上温度が７５０℃以上となるよう熱間製管を行うことによって、最終目的の特性に適した高強度、高靭性でかつ加工性と溶接性に優れたエアーバッグ用鋼管を得ることができる。

【0008】また、本発明の請求項２の高強度高靭性エアーバッグ用鋼管の製造方法は、Ｃ：０．０１%～０．２０%、Ｓｉ：０．５０%以下、Ｍｎ：０．３０%～２．００%、Ｐ：０．０２０%以下、Ｓ：０．０２０%以下、Ａｌ：０．１０%以下を含有し、残部がＦｅおよび不可避的不純物からなる鋼を、最終仕上温度が７５０℃以上となるよう熱間製管を行うこととしている。このように、鋼中の化学成分を上記成分組成に限定することによって、エアーバッグのアキュムレータ用として十分な強度、靭性と高加工性、溶接性を得ることができる。また、上記鋼を最終仕上温度が７５０℃以上となるよう熱間製管を行うことによって、最終目的の特性に適した高強度、高靭性でかつ加工性と溶接性に優れたエアーバッグ用鋼管を得ることができる。

【0009】さらに、本発明の請求項３の高強度高靭性エアーバッグ用鋼管の製造方法は、Ｃ：０．０５%以上０．１５%未満、Ｓｉ：０．５０%以下、Ｍｎ：０．３０%～２．００%、Ｐ：０．０２０%以下、Ｓ：０．０２０%以下、Ａｌ：０．１０%以下を含み、Ｍｏ：０．５０%以下、Ｖ：０．１０%以下、Ｎｉ：０．５０%以下、Ｃｒ：１．００%以下、Ｃｕ：０．５０%以下、Ｔｉ：０．１０%以下、Ｎｂ：０．１０%以下、Ｂ：０．００５%以下のうち１種以上を含有し、残部がＦｅおよび不可避的不純物からなる鋼を、最終仕上温度が７５０℃以上となるよう熱間製管を行うこととしている。このように、鋼中の化学成分を上記成分組成に限定することによって、エアーバッグのアキュムレータ用として十分な高強度、高靭性と高加工性、溶接性を得ることができる。また、上記鋼を最終仕上温度が７５０℃以上となるよう熱間製管を行うことによって、最終目的の特性に適した高強度、高靭性でかつ加工性と溶接性に優れたエアーバッグ用鋼管を得ることができる。

【0010】さらにまた、本発明の請求項４の高強度高靭性エアーバッグ用鋼管の製造方法は、Ｃ：０．０１%～０．２０%、Ｓｉ：０．５０%以下、Ｍｎ：０．３０%～２．００%、Ｐ：０．０２０%以下、Ｓ：０．０２０%以下、Ａｌ：０．１０%以下を含み、Ｍｏ：０．５０%以下、Ｖ：０．１０%以下、Ｎｉ：０．５０%以下、Ｃｒ：１．００%以下、Ｃｕ：０．５０%以下、Ｔｉ：０．１０%以下、Ｎｂ：０．１０%以下、Ｂ：０．００５%以下のうち１種以上を含有し、残部がＦｅおよび不可避的不純物からなる鋼を、最終仕上温度が７５０℃以上となるよう熱間製管を行うこととしている。このように、鋼中の化学成分を上記成分組成に限定することによって、エアーバッグのアキュムレータ用として十分な高強度、高靭性と高加工性、溶接性を得ることができる。また、上記鋼を最終仕上温度が７５０℃以上となるよう熱間製管を行うことによって、最終目的の特性に適した高強度、高靭性でかつ加工性と溶接性に優れたエアーバッグ用鋼管を得ることができる。

【0011】さらにまた、本発明の請求項５の高強度高靭性エアーバッグ用鋼管の製造方法は、Ｃ：０．０５%以上０．１５%未満、Ｓｉ：０．５０%以下、Ｍｎ：０．３０%～２．００%、Ｐ：０．０２０%以下、Ｓ：０．０２０%以下、Ａｌ：０．１０%以下を含有し、残部がＦｅおよび不可避的不純物からなる鋼を熱間製管後、応力除去焼鈍、焼なまし、焼ならし、焼入れのままあるいは焼入れ焼戻し処理を施すこととしている。このように、鋼中の化学成分を上記成分組成に限定することによって、エアーバッグのアキュムレータ用として十分な高強度、高靭性と高加工性、溶接性を得ることができる。また、上記鋼を熱間製管後、応力除去焼鈍、焼なまし、焼ならし、焼入れのままあるいは焼入れ焼戻し処理を施すことによって、最終目的の特性に適した高強度、

高靭性でかつ加工性と溶接性に優れたエアーバッグ用鋼管を得ることができる。

【0012】さらにまた、本発明の請求項6の高強度高靭性エアーバッグ用鋼管の製造方法は、C：0．01%～0．20%、Si：0．50%以下、Mn：0．30%～2．00%、P：0．020%以下、S：0．020%以下、Al：0．10%以下を含有し、残部がFeおよび不可避的不純物からなる鋼を熱間製管後、応力除去焼鈍、焼なまし、焼ならし、焼入れのままあるいは焼入れ焼戻し処理を施すこととしている。このように、鋼中の化学成分を上記成分組成に限定することによって、エアーバッグのアキュムレータ用として十分な高強度、高靭性と高加工性、溶接性を得ることができる。また、上記鋼を熱間製管後、応力除去焼鈍、焼なまし、焼ならし、焼入れのままあるいは焼入れ焼戻し処理を施すことによって、最終目的の特性に適した高強度、高靭性でかつ加工性と溶接性に優れたエアーバッグ用鋼管を得ることができる。

【0013】さらにまた、本発明の請求項7の高強度高靭性エアーバッグ用鋼管の製造方法は、C：0．05%以上0．15%未満、Si：0．50%以下、Mn：0．30%～2．00%、P：0．020%以下、S：0．020%以下、Al：0．10%以下を含み、Mo：0．50%以下、V：0．10%以下、Ni：0．50%以下、Cr：1．00%以下、Cu：0．50%以下、Ti：0．10%以下、Nb：0．10%以下、B：0．005%以下のうち1種以上を含有し、残部がFeおよび不可避的不純物からなる鋼を熱間製管後、応力除去焼鈍、焼なまし、焼ならし、焼入れのままあるいは焼入れ焼戻し処理を施すこととしている。このように、鋼中の化学成分を上記成分組成に限定することによって、エアーバッグのアキュムレータ用として十分な高強度、高靭性と高加工性、溶接性を得ることができる。また、上記鋼を熱間製管後、応力除去焼鈍、焼なまし、焼ならし、焼入れのままあるいは焼入れ焼戻し処理を施すことによって、最終目的の特性に適した高強度、高靭性でかつ加工性と溶接性に優れたエアーバッグ用鋼管を得ることができる。

【0014】さらにまた、本発明の請求項8の高強度高靭性エアーバッグ用鋼管の製造方法は、C：0．01%～0．20%、Si：0．50%以下、Mn：0．30%～2．00%、P：0．020%以下、S：0．020%以下、Al：0．10%以下を含み、Mo：0．50%以下、V：0．10%以下、Ni：0．50%以下、Cr：1．00%以下、Cu：0．50%以下、Ti：0．10%以下、Nb：0．10%以下、B：0．005%以下のうち1種以上を含有し、残部がFeおよび不可避的不純物からなる鋼を熱間製管後、応力除去焼鈍、焼なまし、焼ならし、焼入れのままあるいは焼入れ焼戻し処理を施すこととしている。このように、鋼中の化学成分を上記成分組成に限定することによって、エアーバッグのアキュムレータ用として十分な高強度、高靭性と高加工性、溶接性を得ることができる。また、上記鋼を熱間製管後、応力除去焼鈍、焼なまし、焼ならし、焼入れのままあるいは焼入れ焼戻し処理を施すことによって、最終目的の特性に適した高強度、高靭性でかつ加工性と溶接性に優れたエアーバッグ用鋼管を得ることができる。

【0015】

【発明の実施の形態】先ず本発明で使用する鋼材の化学成分に関する限定理由は以下のとおりである。Cは鋼の必要な強度を安価に得るために添加する元素であるが、0．01%未満では十分な強度が得られず、また、0．20%を超えると加工性ならびに溶接性が悪化すると共に、靭性が低下するため、0．01～0．20%としたが、特に好ましい範囲は、0．05%以上0．15%未満である。

【0016】Siは鋼の冷間加工性を阻害する元素であり、0．50%を超えると加工性が悪化するため、0．50%以下とした。

【0017】Mnは鋼の強度と靭性を向上させるのに有効な元素であるが、0．30%未満では十分な強度と靭性が得られず、また、2．00%を超えると溶接性が悪化するため、0．30～2．00%とした。

【0018】Pは粒界偏析に起因する靭性低下をもたらすため、0．020%以下とした。Sは鋼中のMnと化合してMnSによる介在物を形成し、加工性の悪化ならびに靭性を低下させるため、0．020%以下とした。

【0019】Alは加工性を向上させるのに有効な元素があるが、0．10%を超えるとその効果が小さくなるため、0．10%以下とした。

【0020】鋼中の上記化学成分を限定することによって、エアーバッグのアキュムレータ用として十分な強度、靭性と高加工性、溶接性を得ることができるが、さらにこれらを向上させたい場合、上記化学成分にさらにMo、V、Ni、Cr、Cu、Ti、Nb、Bを添加することが有効である。これら添加成分の含有量の限定理由は以下のとおりである。

【0021】Moは固溶強化により高強度化すると共に、焼入れ性を向上する効果があるが、0．50%を超えると溶接部が硬化し、靭性が低下するため、0．50%以下とした。

【0022】Vは析出物を生成し強度を向上させる効果があるが、0．10%を超えると溶接部の靭性が低下するため、0．10%以下とした。

【0023】Niは焼入れ性を改善すると共に靭性を向上させるのに有効な元素であるが、0．50%を超えるとエアーバッグ用としての効果が期待されず、しかも高価な元素であるため、0．50%以下とした。

【0024】Crは鋼の強度と耐食性を向上させるのに

有効な元素であるが、１．００％を超えると加工性ならびに溶接部の靭性を低下させるため、１．００％以下とした。

【００２５】Ｃｕは鋼の耐食性を向上させるのに有効な元素であるが、０．５０％を超えると熱間加工性を悪化させるため、０．５０％以下とした。

【００２６】Ｔｉは組織を微細化することにより靭性の向上に有効であるが、０．１０％を超えると逆に靭性を悪化させるため、０．１０％以下とした。

【００２７】ＮｂはＴｉと同様に組織を微細化することにより靭性の向上に有効であるが、０．１０％を超えると逆に靭性を悪化させるため、０．１０％以下とした。

【００２８】Ｂは焼入れ性を改善するのに有効な元素であるが、０．００５％を超えると靭性を低下させるため、０．００５％以下とした。

【００２９】本発明においては、上記のように化学成分を調整した鋼材を素材として用いて熱間製管する。熱間製管時の最終仕上温度を７５０℃以上とすることによって、靭性を付与する。また、熱間製管時の最終仕上温度が７５０℃未満では、均一なオーステナイト粒が得られず、高靭性が得られない。したがって、本発明においては、熱間製管時の最終仕上温度が７５０℃に満たない場合、あるいは熱間製管ままの状態では必要とする強度、靭性、加工性が得られない場合には、熱間製管後、応力除去焼鈍、焼なまし、焼ならし、焼入れのままあるいは焼入れ焼戻し処理を施すことにより、高強度、高靭性で、かつ加工性、溶接性に優れたエアーバッグ用鋼管を得ることができる。

【００３０】

＊【実施例】表１に示す化学成分の本発明鋼および表２に示す化学成分の比較鋼のビレットを用い、マンネスマン－マンドレルミル方式による穿孔、圧延を行ったのち、レデューサにより最終仕上温度７００～８５０℃で外径７６．２ｍｍ、肉厚４．０ｍｍに仕上げた。この後、熱間製管のままあるいは５００℃で応力除去焼鈍、９００℃で焼ならし処理、６００℃で焼なまし処理、９００℃で焼入れのまま、あるいは９００℃で焼入れ５００℃で焼戻しの熱処理を行い、各種の特性を評価した。その結果を表３および表４に示す。

【００３１】特性の評価は、強度、靭性、加工性について実施した。強度については、ＪＩＳ　Ｚ２２０１の金属材料引張試験片に規定の１１号試験片を用い、ＪＩＳ　Ｚ２２４１の金属材料引張試験方法に準じて引張試験を行った。靭性については、図１に示すとおり、継目無鋼管１を鎖線で示すように半割となし、長さ１０ｍｍの半割試験片２を採取し、図２に示す落重試験装置の置台３上に半割試験片２を載置し、重さ５ｋｇの重錘４を置台３上面から２０００ｍｍの位置より落下させ、割れの有無を調査した。なお、落重試験は、－４０℃において１０ケ繰り返して試験し、割れ率で評価した。加工性については、へん平性で評価した。なお、へん平性は、図３に示すとおり、先端Ｒが１０ｍｍのＶブロック（６０°）の押工具５、５を用いて継目無鋼管１が密着するまでへん平にし、最大へん平部の肩部６に割れの発生有無により評価し、割れの発生無は○、割れの発生有は×とした。

【００３２】

＊【表１】

	鋼No.	化学成分 (%)													
		C	Si	Mn	P	S	Al	Mo	V	Ni	Cr	Cu	Ti	Nb	B
本発明鋼	1	0.10	0.30	1.30	0.010	0.010	0.020	–	–	–	–	–	–	–	–
	2	0.02	0.27	1.27	0.012	0.012	0.018	–	–	–	–	–	–	–	–
	3	0.19	0.29	1.28	0.011	0.010	0.023	–	–	–	–	–	–	–	–
	4	0.11	0.48	1.28	0.010	0.010	0.020	–	–	–	–	–	–	–	–
	5	0.11	0.25	0.34	0.009	0.011	0.024	–	–	–	–	–	–	–	–
	6	0.10	0.27	1.90	0.012	0.012	0.020	–	–	–	–	–	–	–	–
	7	0.09	0.30	1.31	0.019	0.010	0.025	–	–	–	–	–	–	–	–
	8	0.10	0.31	1.29	0.011	0.018	0.026	–	–	–	–	–	–	–	–
	9	0.11	0.31	1.30	0.012	0.011	0.085	–	–	–	–	–	–	–	–
	10	0.11	0.28	1.28	0.009	0.012	0.025	0.22	–	–	–	–	–	–	–
	11	0.10	0.30	1.27	0.008	0.011	0.020	–	0.07	–	–	–	–	–	–
	12	0.09	0.29	1.31	0.012	0.011	0.023	–	–	0.38	–	0.31	–	–	–
	13	0.10	0.33	1.29	0.011	0.011	0.025	–	–	–	0.61	–	–	–	–
	14	0.10	0.30	1.31	0.010	0.012	0.020	–	–	–	–	–	0.040	–	–
	15	0.09	0.31	1.28	0.012	0.008	0.024	–	–	–	–	–	–	0.04	–
	16	0.11	0.30	1.30	0.012	0.011	0.021	–	–	–	–	–	0.003	–	0.0012
	17	0.11	0.29	1.28	0.012	0.010	0.025	–	–	–	–	–	–	–	–
	18	0.10	0.30	1.30	0.010	0.010	0.020	–	–	–	–	–	–	–	–
	19	0.10	0.29	1.28	0.010	0.011	0.024	–	–	–	–	–	–	0.04	–

【００３３】

※　※【表２】

	鋼 No.	化学成分 (%)													
		C	Si	Mn	P	S	Al	Mo	V	Ni	Cr	Cu	Ti	Nb	B
比較鋼	20	0.008*	0.28	1.29	0.011	0.010	0.027	–	–	–	–	–	–	–	–
	21	0.24*	0.29	1.31	0.009	0.008	0.029	–	–	–	–	–	–	–	–
	22	0.11	0.54*	1.30	0.011	0.012	0.025	–	–	–	–	–	–	–	–
	23	0.10	0.30	0.21*	0.012	0.011	0.024	–	–	–	–	–	–	–	–
	24	0.10	0.28	2.15*	0.010	0.009	0.023	–	–	–	–	–	–	–	–
	25	0.11	0.27	1.29	0.029*	0.010	0.025	–	–	–	–	–	–	–	–
	26	0.09	0.29	1.29	0.010	0.030*	0.024	–	–	–	–	–	–	–	–
	27	0.10	0.30	1.28	0.011	0.011	0.115*	–	–	–	–	–	–	–	–

*印はこの発明の範囲外

【0034】　　＊　＊【表3】

	試験 No.	鋼 No.	製管仕上 温度(℃)	最終熱処理 種類	引張強さ (N/mm²)	落重試験 割れ率(%)	密着 へん平
本発明例	1	1	850	焼入れ焼戻し	696	0	○
	2	2	850	焼入れ焼戻し	677	0	○
	3	3	850	焼入れ焼戻し	775	0	○
	4	4	850	焼入れ焼戻し	716	0	○
	5	5	850	焼入れ焼戻し	628	0	○
	6	6	850	焼入れ焼戻し	765	0	○
	7	7	850	焼入れ焼戻し	686	0	○
	8	8	850	焼入れ焼戻し	706	0	○
	9	9	850	焼入れ焼戻し	706	0	○
	10	10	850	焼入れ焼戻し	726	0	○
	11	11	850	焼入れ焼戻し	726	0	○
	12	12	850	焼入れ焼戻し	696	0	○
	13	13	850	焼入れ焼戻し	765	0	○
	14	14	850	焼入れ焼戻し	716	0	○
	15	15	850	焼入れ焼戻し	706	0	○
	16	16	850	焼入れ焼戻し	765	0	○
	17	17	850	焼ならし	657	0	○
	18	18	850	焼なまし	598	0	○
	19	18	850	熱間製管まま	618	0	○
	20	18	800	焼入れ焼戻し	716	0	○
	21	18	700	焼入れまま	740	0	○
	22	18	700	応力除去焼鈍	675	0	○
	23	19	700	焼ならし	650	0	○
	24	19	700	焼なまし	625	0	○
	25	19	700	焼入れまま	756	0	○
	26	19	700	焼入れ焼戻し	725	0	○

【0035】　　※40※【表4】

11　　12

	試験No.	鋼No.	製管仕上温度(℃)	最終熱処理種類	引張強さ(N/mm²)	落重試験割れ率(%)	密着へん平	備考
比較例	27	20	850	焼入れ焼戻し	520	0	○	強度不足
	28	21	850	焼入れ焼戻し	834	30	×	靭性加工性不足
	29	22	850	焼入れ焼戻し	726	20	×	靭性加工性不足
	30	23	850	焼入れ焼戻し	539	0	○	強度不足
	31	24	850	焼入れ焼戻し	814	30	×	靭性加工性不足
	32	25	850	焼入れ焼戻し	696	20	×	靭性加工性不足
	33	26	850	焼入れ焼戻し	686	20	×	靭性加工性不足
	34	27	850	焼入れ焼戻し	726	30	×	靭性加工性不足
	35	18	700*	熱間製管まま*	736	40	×	靭性加工性不足

(注)　*印は本発明の範囲外を示す。

【００３６】表１、表３に示すとおり、鋼Ｎｏ．１～１９の本発明鋼を用いた試験Ｎｏ．１～２６の本発明例は、いずれの成分、プロセスにおいても、引張強さが５９０Ｎ／ｍｍ²以上の高強度で、しかも、落重試験での割れ率が０％、さらに、へん平後の肩部の割れがなく、良好な加工性を有していた。

【００３７】これに対し、表２、表４に示すとおり、鋼Ｎｏ．２０～２７の比較鋼および鋼Ｎｏ．１８の本発明鋼を用いた試験Ｎｏ．２７～３５の比較例は、鋼Ｎｏ．２０、２３を用いた試験Ｎｏ．２７、３０は引張強さが５９０Ｎ／ｍｍ²以下で強度不足、また、鋼Ｎｏ．２１、２２、２４～２７、１８を用いた試験Ｎｏ．２８、２９、３１～３５は、落重試験での割れ率が１０％以上で、しかも密着へん平後の肩部の割れが発生し、靭性ならびに加工性が不足している。

【００３８】

【発明の効果】本発明の請求項１～４の高強度、高靭性エアーバッグ用鋼管の製造方法は、化学成分を調整した鋼を、最終仕上温度が７５０℃以上となるよう熱間製管を行うことによって、エアーバッグ用のアキュムレータ等の用途に適した加工性、溶接性に優れ、かつ高強度、高靭性鋼管を得ることができる。

＊【００３９】本発明の請求項５～８の高強度、高靭性エアーバッグ用鋼管の製造方法は、化学成分を調整した鋼を熱間製管後、応力除去焼鈍、焼なまし、焼ならし、焼入れのままあるいは焼入れ焼戻し処理を施すことによって、最終目標の特性に適した高強度、高靭性で加工性、溶接性に優れたエアーバッグのアキュムレータ用の鋼管を製造することができる。

【図面の簡単な説明】

【図１】実施例における落重試験片の説明図で、（ａ）図は半割方法の斜視図、（ｂ）図は落重試験片の斜視図である。

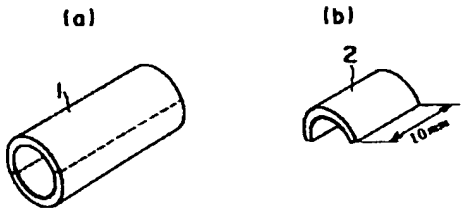
【図２】実施例における落重試験方法説明のための概略説明図である。

【図３】実施例における密着へん平試験方法説明のための概略説明図である。

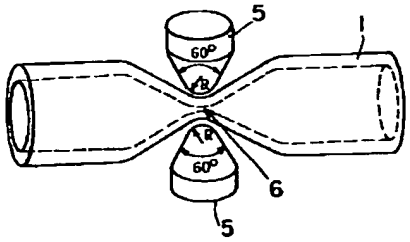
【符号の説明】

１　継目無鋼管
２　半割試験片
３　置台
４　重錘
５　押工具
６　肩部

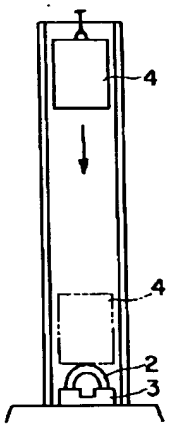
【図１】



【図３】



【図2】



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(51)Int.Cl.[6]	識別記号	FI
C22C 38/06		C22C 38/06
38/58		38/58

.* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

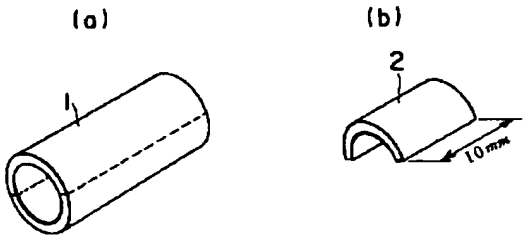
[Claim(s)]
[Claim 1] The manufacture approach of the steel pipe for high intensity quantity toughness air bags characterized by performing tube manufacturing between heat so that the last finishing temperature may become 750 degrees C or more about the steel with which less than [aluminum:0.10%] is contained less than 0.15% C:0.05% or more less than [Si:0.50%], Mn:0.30%-2.00%, P:0.020% or less, and S:0.020% or less, and the remainder consists of Fe and an unescapable impurity.
[Claim 2] The manufacture approach of the steel pipe for high intensity quantity toughness air bags characterized by performing tube manufacturing between heat so that the last finishing temperature may become 750 degrees C or more C:0.01% to 0.20% about the steel with which less than [aluminum:0.10%] is contained and the remainder consists of Fe and an unescapable impurity less than [Si:0.50%], Mn:0.30%-2.00%, P:0.020% or less, and S:0.020% or less.
[Claim 3] Less than 0.15% C:0.05% or more, less than [Si:0.50%], Mn:0.30%-2.00%, Less than [aluminum:0.10%] is included P:0.020% or less and S:0.020% or less. Mo: Less than [0.50%], V:0.10% or less, less than [nickel:0.50%], Cr: Less than [1.00%], less than [Cu:0.50%], less than [Ti:0.10%], Nb: The manufacture approach of the steel pipe for high intensity quantity toughness air bags characterized by performing tube manufacturing between heat so that the last finishing temperature may become 750 degrees C or more about the steel with which one or more of less than [0.10%] and B:0.005% or less of sorts are contained, and the remainder consists of Fe and an unescapable impurity.
[Claim 4] C:0.01% - 0.20%, less than [Si:0.50%], Mn:0.30%-2.00%, Less than [aluminum:0.10%] is included P:0.020% or less and S:0.020% or less. Mo: Less than [0.50%], V:0.10% or less, less than [nickel:0.50%], Cr: Less than [1.00%], less than [Cu:0.50%], less than [Ti:0.10%], Nb: The manufacture approach of the steel pipe for high intensity quantity toughness air bags characterized by performing tube manufacturing between heat so that the last finishing temperature may become 750 degrees C or more about the steel with which one or more of less than [0.10%] and B:0.005% or less of sorts are contained, and the remainder consists of Fe and an unescapable impurity.
[Claim 5] The manufacture approach of the steel pipe for high intensity quantity toughness air bags characterized by performing hardening tempering processing with stress relieving annealing, annealing, normalizing, and hardening for the steel with which less than [aluminum:0.10%] is contained less than 0.15% C:0.05% or more less than [Si:0.50%], Mn:0.30%-2.00%, P:0.020% or less, and S:0.020% or less, and the remainder consists of Fe and an unescapable impurity after tube manufacturing between heat.
[Claim 6] The manufacture approach of the steel pipe for high intensity quantity toughness air bags characterized by performing hardening tempering processing with stress relieving annealing, annealing, normalizing, and hardening for the steel with which less than [aluminum:0.10%] is contained and the remainder consists of Fe and an unescapable impurity after tube manufacturing between heat C:0.01% to 0.20% less than [Si:0.50%], Mn:0.30%-2.00%, P:0.020% or less, and S:0.020% or less.
[Claim 7] Less than 0.15% C:0.05% or more, less than [Si:0.50%], Mn:0.30%-2.00%, Less than [aluminum:0.10%] is included P:0.020% or less and S:0.020% or less. Mo: Less than [0.50%],

V:0.10% or less, less than [nickel:0.50%], Cr: Less than [1.00%], less than [Cu:0.50%], less than [Ti:0.10%], One or more of less than [Nb:0.10%] and B:0.005% or less of sorts are contained. The manufacture approach of the steel pipe for high intensity quantity toughness air bags characterized by performing hardening tempering processing with stress relieving annealing, annealing, normalizing, and hardening for the steel with which the remainder consists of Fe and an unescapable impurity after tube manufacturing between heat.

[Claim 8] C:0.01% - 0.20%, less than [Si:0.50%], Mn:0.30%-2.00%, Less than [aluminum:0.10%] is included P:0.020% or less and S:0.020% or less. Mo: Less than [0.50%], V:0.10% or less, less than [nickel:0.50%], Cr: Less than [1.00%], less than [Cu:0.50%], less than [Ti:0.10%], One or more of less than [Nb:0.10%] and B:0.005% or less of sorts are contained. The manufacture approach of the steel pipe for high intensity quantity toughness air bags characterized by performing hardening tempering processing with stress relieving annealing, annealing, normalizing, and hardening for the steel with which the remainder consists of Fe and an unescapable impurity after tube manufacturing between heat.

[Translation done.]

Drawing selection drawing 1



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the manufacture approach of the high intensity quantity toughness steel pipe suitable for the components for air bags with which it excels in workability and weldability, and the high intensity of two or more [590Ns //mm] and high toughness are demanded.
[0002]
[Description of the Prior Art] Although installation of the equipment which pursued safety is positively advanced in the automobile industry in recent years, before crew collides with a handle, an instrument panel, etc. also in it at the time of a collision, development loading of the air bag system which is made to develop an air bag by gas etc. between them and crew, absorbs crew's kinetic energy, and aims at trauma mitigation has come to be carried out.
[0003] Although the method which uses an explosive chemical conventionally had been adopted as an air bag system, it is expensive and the system which uses the accumulator made from an argon gas-charging steel pipe from an environmental problem and a recycle problem in recent years was developed. After the steel pipe used for accumulators, such as argon gas, always maintains at 300 kgf/cm2 the inert gas which blows off in an air bag at the time of a collision, since the gas at the time of little powder ignition is added at the time of a collision, gas is made to blow off at a stretch and stress is added with the very big strain rate for a short time, unlike the mere structure like the conventional pressure cylinder or a line pipe, workability and weldability are required with high intensity and high toughness.
[0004]
[Problem(s) to be Solved by the Invention] Since workability and weldability are required with high intensity and high toughness, toughness cannot fall by high intensity-ization and the steel pipe used for the new field for said accumulators cannot be satisfied with the combination of conventional cold-drawn processing and stress relieving annealing of the above-mentioned demand.
[0005] The purpose of this invention is to offer the manufacture approach of the steel pipe for high intensity quantity toughness air bags suitable for the components for air bags with which it excels in workability and weldability, and high intensity and high toughness are demanded as a new field of the conventional technique which is not.
[0006]
[Means for Solving the Problem] this invention persons repeated test research wholeheartedly that the above-mentioned purpose should be attained. Consequently, it studied that manufacture the steel of a predetermined component between heat so that the last finishing temperature may become 750 degrees C or more, or excelled the steel of a predetermined component in workability and weldability by performing hardening tempering processing with stress relieving annealing, annealing, normalizing, and hardening after tube manufacturing between heat, and high intensity and a high toughness steel pipe were obtained, and this invention was reached.
[0007] The manufacture approach of the steel pipe for high intensity quantity toughness air bags of

claim 1 of this invention contains less than [aluminum:0.10%] less than 0.15% C:0.05% or more less than [Si:0.50%], Mn:0.30%-2.00%, P:0.020% or less, and S:0.020% or less, and is presupposing it that tube manufacturing between heat is performed so that the last finishing temperature may become 750 degrees C or more about the steel with which the remainder consists of Fe and an unescapable impurity. Thus, reinforcement sufficient as an object for the accumulators of an air bag, toughness, high workability, and weldability can be obtained by limiting the chemical entity in steel to the above-mentioned component presentation. Moreover, the steel pipe for air bags which is the high intensity and the high toughness suitable for the property of the last purpose, and was excellent in workability and weldability can be obtained by performing tube manufacturing between heat so that the last finishing temperature may become 750 degrees C or more about the above-mentioned steel.

[0008] Moreover, less than [Si:0.50%], Mn:0.30%-2.00%, P:0.020% or less, and S:0.020% or less, the manufacture approach of the steel pipe for high intensity quantity toughness air bags of claim 2 of this invention contains less than [aluminum:0.10%], and is presupposing it that tube manufacturing between heat is performed so that the last finishing temperature may become 750 degrees C or more about the steel with which the remainder consists of Fe and an unescapable impurity C:0.01% to 0.20%. Thus, reinforcement sufficient as an object for the accumulators of an air bag, toughness, high workability, and weldability can be obtained by limiting the chemical entity in steel to the above-mentioned component presentation. Moreover, the steel pipe for air bags which is the high intensity and the high toughness suitable for the property of the last purpose, and was excellent in workability and weldability can be obtained by performing tube manufacturing between heat so that the last finishing temperature may become 750 degrees C or more about the above-mentioned steel.

[0009] Furthermore, the manufacture approach of the steel pipe for high intensity quantity toughness air bags of claim 3 of this invention Less than 0.15% C:0.05% or more, less than [Si:0.50%], Mn:0.30%-2.00%, Less than [aluminum:0.10%] is included P:0.020% or less and S:0.020% or less. Mo: Less than [0.50%], V:0.10% or less, less than [nickel:0.50%], Cr: Less than [1.00%], less than [Cu:0.50%], less than [Ti:0.10%], Nb: Contain one or more of less than [0.10%] and B:0.005% or less of sorts, and suppose that tube manufacturing between heat is performed so that the last finishing temperature may become 750 degrees C or more about the steel with which the remainder consists of Fe and an unescapable impurity. Thus, high intensity sufficient as an object for the accumulators of an air bag, high toughness, high workability, and weldability can be obtained by limiting the chemical entity in steel to the above-mentioned component presentation. Moreover, the steel pipe for air bags which is the high intensity and the high toughness suitable for the property of the last purpose, and was excellent in workability and weldability can be obtained by performing tube manufacturing between heat so that the last finishing temperature may become 750 degrees C or more about the above-mentioned steel.

[0010] Further again the manufacture approach of the steel pipe for high intensity quantity toughness air bags of claim 4 of this invention C:0.01% - 0.20%, less than [Si:0.50%], Mn:0.30%-2.00%, Less than [aluminum:0.10%] is included P:0.020% or less and S:0.020% or less. Mo: Less than [0.50%], V:0.10% or less, less than [nickel:0.50%], Cr: Less than [1.00%], less than [Cu:0.50%], less than [Ti:0.10%], Nb: Contain one or more of less than [0.10%] and B:0.005% or less of sorts, and suppose that tube manufacturing between heat is performed so that the last finishing temperature may become 750 degrees C or more about the steel with which the remainder consists of Fe and an unescapable impurity. Thus, high intensity sufficient as an object for the accumulators of an air bag, high toughness, high workability, and weldability can be obtained by limiting the chemical entity in steel to the above-mentioned component presentation. Moreover, the steel pipe for air bags which is the high intensity and the high toughness suitable for the property of the last purpose, and was excellent in workability and weldability can be obtained by performing tube manufacturing between heat so that the last finishing temperature may become 750 degrees C or more about the above-mentioned steel.

[0011] Further again the manufacture approach of the steel pipe for high intensity quantity toughness air bags of claim 5 of this invention Less than 0.15% C:0.05% or more, less than [Si:0.50%], Mn:0.30%-2.00%, P:0.020% or less and S:0.020% or less, less than [aluminum:0.10%] is contained and suppose the steel with which the remainder consists of Fe and an unescapable impurity that hardening tempering

processing with stress relieving annealing, annealing, normalizing, and hardening is performed after tube manufacturing between heat. Thus, high intensity sufficient as an object for the accumulators of an air bag, high toughness, high workability, and weldability can be obtained by limiting the chemical entity in steel to the above-mentioned component presentation. Moreover, the steel pipe for air bags which is the high intensity and the high toughness which were suitable for the property of the last purpose in the above-mentioned steel by performing hardening tempering processing with stress relieving annealing, annealing, normalizing, and hardening after tube manufacturing between heat, and was excellent in workability and weldability can be obtained.

[0012] Further again the manufacture approach of the steel pipe for high intensity quantity toughness air bags of claim 6 of this invention C:0.01% - 0.20%, less than [Si:0.50%], Mn:0.30%-2.00%, P:0.020% or less and S:0.020% or less, less than [aluminum:0.10%] is contained and suppose the steel with which the remainder consists of Fe and an unescapable impurity that hardening tempering processing with stress relieving annealing, annealing, normalizing, and hardening is performed after tube manufacturing between heat. Thus, high intensity sufficient as an object for the accumulators of an air bag, high toughness, high workability, and weldability can be obtained by limiting the chemical entity in steel to the above-mentioned component presentation. Moreover, the steel pipe for air bags which is the high intensity and the high toughness which were suitable for the property of the last purpose in the above-mentioned steel by performing hardening tempering processing with stress relieving annealing, annealing, normalizing, and hardening after tube manufacturing between heat, and was excellent in workability and weldability can be obtained.

[0013] Further again the manufacture approach of the steel pipe for high intensity quantity toughness air bags of claim 7 of this invention Less than 0.15% C:0.05% or more, less than [Si:0.50%], Mn:0.30%-2.00%, Less than [aluminum:0.10%] is included P:0.020% or less and S:0.020% or less. Mo: Less than [0.50%], V:0.10% or less, less than [nickel:0.50%], Cr: Less than [1.00%], less than [Cu:0.50%], less than [Ti:0.10%], Nb: One or more of less than [0.10%] and B:0.005% or less of sorts are contained, and suppose the steel with which the remainder consists of Fe and an unescapable impurity that hardening tempering processing with stress relieving annealing, annealing, normalizing, and hardening is performed after tube manufacturing between heat. Thus, high intensity sufficient as an object for the accumulators of an air bag, high toughness, high workability, and weldability can be obtained by limiting the chemical entity in steel to the above-mentioned component presentation. Moreover, the steel pipe for air bags which is the high intensity and the high toughness which were suitable for the property of the last purpose in the above-mentioned steel by performing hardening tempering processing with stress relieving annealing, annealing, normalizing, and hardening after tube manufacturing between heat, and was excellent in workability and weldability can be obtained.

[0014] Further again the manufacture approach of the steel pipe for high intensity quantity toughness air bags of claim 8 of this invention C:0.01% - 0.20%, less than [Si:0.50%], Mn:0.30%-2.00%, Less than [aluminum:0.10%] is included P:0.020% or less and S:0.020% or less. Mo: Less than [0.50%], V:0.10% or less, less than [nickel:0.50%], Cr: Less than [1.00%], less than [Cu:0.50%], less than [Ti:0.10%], Nb: One or more of less than [0.10%] and B:0.005% or less of sorts are contained, and suppose the steel with which the remainder consists of Fe and an unescapable impurity that hardening tempering processing with stress relieving annealing, annealing, normalizing, and hardening is performed after tube manufacturing between heat. Thus, high intensity sufficient as an object for the accumulators of an air bag, high toughness, high workability, and weldability can be obtained by limiting the chemical entity in steel to the above-mentioned component presentation. Moreover, the steel pipe for air bags which is the high intensity and the high toughness which were suitable for the property of the last purpose in the above-mentioned steel by performing hardening tempering processing with stress relieving annealing, annealing, normalizing, and hardening after tube manufacturing between heat, and was excellent in workability and weldability can be obtained.

[0015]

[Embodiment of the Invention] The reason for limitation about the chemical entity of the steel materials first used by this invention is as follows. Although it considered as 0.01 - 0.20% since toughness fell

while workability and weldability got worse when reinforcement sufficient at less than 0.01% was not obtained and it exceeded 0.20% although it was the element added in order that C may obtain the required reinforcement of steel cheaply, especially the desirable range is less than 0.15% 0.05% or more.

[0016] Si was an element which checks the cold-working nature of steel, and since workability would get worse if it exceeds 0.50%, it could be 0.50% or less.
[0017] Although Mn was an element effective in raising the reinforcement and the toughness of steel, since weldability would get worse if reinforcement and toughness sufficient at less than 0.30% are not acquired and it exceeds 2.00%, it could be 0.30 - 2.00%.
[0018] P could be 0.020% or less in order to bring about the toughness fall resulting from grain boundary segregation. In order that S might combine with Mn in steel, might form the inclusion by MnS and might reduce aggravation and the toughness of workability, it could be 0.020% or less.
[0019] Although aluminum had an element effective in raising workability, since the effectiveness would become small if it exceeds 0.10%, it could be 0.10% or less.
[0020] Although reinforcement sufficient as an object for the accumulators of an air bag, toughness, high workability, and weldability can be obtained by limiting the above-mentioned chemical entity in steel, when these want to improve further, it is effective in the above-mentioned chemical entity to add Mo, V, nickel, Cr, Cu, Ti, Nb, and B further. The reason for limitation of the content of these addition component is as follows.
[0021] Mo was effective in improving hardenability while high-intensity-izing it by solid solution strengthening, but since a weld zone would harden and toughness would fall if it exceeds 0.50%, it could be 0.50% or less.
[0022] Although V was effective in generating a sludge and raising reinforcement, since the toughness of a weld zone would fall if it exceeds 0.10%, it could be 0.10% or less.
[0023] nickel was an element effective in raising toughness while having improved hardenability, but when it exceeded 0.50%, the effectiveness as an object for air bags was not expected, but moreover, since it was an expensive element, it could be 0.50% or less.
[0024] Although Cr was an element effective in raising the reinforcement of steel, and corrosion resistance, if it exceeds 1.00%, in order to reduce workability and the toughness of a weld zone, it could be 1.00% or less.
[0025] Although Cu was an element effective in raising the corrosion resistance of steel, if it exceeds 0.50%, in order to worsen hot-working nature, it could be 0.50% or less.
[0026] Although Ti was effective in improvement in toughness by making an organization detailed, if it exceeds 0.10%, in order to worsen toughness conversely, it could be 0.10% or less.
[0027] Although Nb was effective in improvement in toughness by making an organization detailed like Ti, if it exceeds 0.10%, in order to worsen toughness conversely, it could be 0.10% or less.
[0028] Although B was an element effective in improving hardenability, if it exceeds 0.005%, in order to reduce toughness, it could be 0.005% or less.
[0029] In this invention, tubes are manufactured between heat, using as a material the steel materials which adjusted the chemical entity as mentioned above. Toughness is given by making the last finishing temperature at the time of tube manufacturing between heat into 750 degrees C or more. Moreover, an austenite grain with the last finishing temperature uniform at less than 750 degrees C at the time of tube manufacturing between heat is not obtained, and high toughness is not acquired. therefore, in this invention, when the last finishing temperature at the time of tube manufacturing between heat does not fulfill 750 degrees C, or when the reinforcement needed in the condition of a heat tube-manufacturing as, toughness, and workability are not acquired The steel pipe for air bags which are high intensity and high toughness and was excellent in workability and weldability can be obtained after tube manufacturing between heat by performing hardening tempering processing with stress relieving annealing, annealing, normalizing, and hardening.
[0030]
[Example] After performing punching by the Mannesmann-mandrel mill method, and rolling using the

billet of the comparison steel of the chemical entity shown in this invention steel and Table 2 of a chemical entity showing in Table 1, the outer diameter of 76.2mm and the thickness of 4.0mm were made with the last finishing temperature of 700-850 degrees C by the reducer. Then, 500 degrees C [of hardening] annealing at 900 degrees C annealing processing and with 900-degree C hardening by normalizing processing and 600 degrees C was heat-treated by stress relieving annealing and 900 degrees C at 500 degrees C with tube manufacturing between heat, and various kinds of properties were evaluated. The result is shown in Table 3 and 4.

[0031] Evaluation of a property was carried out about reinforcement, toughness, and workability. About reinforcement, it is JIS. A regular No. 11 test piece is used for the metallic material test piece for tensile test of Z2201, and it is JIS. The tension test was performed according to the metallic material tension test approach of Z2241. About toughness, the half-segmented test piece 2 was laid on the table 3 of the drop weight test equipment which extracts half-segmented, nothing, and the half-segmented test piece 2 with a die length of 10mm as the chain line shows, and shows seamless steel tubes 1 to drawing 2 , the weight 4 with a weight of 5kg was dropped from the location of 2000mm from table 3 top face, and the existence of a crack was investigated as shown in drawing 1 . In addition, ten drop weight tests were repeatedly examined in -40 degrees C, and the rate of a crack estimated them. Flat nature estimated workability. In addition, it was made flat until seamless steel tubes 1 stuck flat nature using ****** 5 and 5 of the V block (60 degrees) whose tip R is 10mm as it was shown in drawing 3 R> 3, and it evaluated by generating existence of a crack to the shoulder 6 of the maximum flat section, and nothing [generating] of a crack made ****** of O and a crack x.

[0032]

[Table 1]

	鋼 No.	化学成分 (%) C	Si	Mn	P	S	Al	Mo	V	Ni	Cr	Cu	Ti	Nb	B
本発明鋼	1	0.10	0.30	1.30	0.010	0.010	0.020	-	-	-	-	-	-	-	-
	2	0.02	0.27	1.27	0.012	0.012	0.018	-	-	-	-	-	-	-	-
	3	0.19	0.29	1.28	0.011	0.010	0.023	-	-	-	-	-	-	-	-
	4	0.11	0.48	1.28	0.010	0.010	0.020	-	-	-	-	-	-	-	-
	5	0.11	0.25	0.34	0.009	0.011	0.024	-	-	-	-	-	-	-	-
	6	0.10	0.27	1.90	0.012	0.012	0.020	-	-	-	-	-	-	-	-
	7	0.09	0.30	1.31	0.019	0.010	0.025	-	-	-	-	-	-	-	-
	8	0.10	0.31	1.29	0.011	0.018	0.026	-	-	-	-	-	-	-	-
	9	0.11	0.31	1.30	0.012	0.011	0.085	-	-	-	-	-	-	-	-
	10	0.11	0.28	1.28	0.009	0.012	0.025	0.22	-	-	-	-	-	-	-
	11	0.10	0.30	1.27	0.008	0.011	0.020	-	0.07	-	-	-	-	-	-
	12	0.09	0.29	1.31	0.012	0.011	0.023	-	-	0.38	-	0.31	-	-	-
	13	0.10	0.33	1.29	0.011	0.011	0.025	-	-	-	0.51	-	-	-	-
	14	0.10	0.30	1.31	0.010	0.012	0.020	-	-	-	-	-	0.040	-	-
	15	0.09	0.31	1.28	0.012	0.008	0.024	-	-	-	-	-	-	0.04	-
	16	0.11	0.30	1.30	0.012	0.011	0.021	-	-	-	-	-	0.003	-	0.0012
	17	0.11	0.29	1.28	0.012	0.010	0.025	-	-	-	-	-	-	-	-
	18	0.10	0.30	1.30	0.010	0.010	0.020	-	-	-	-	-	-	-	-
	19	0.10	0.29	1.28	0.010	0.011	0.024	-	-	-	-	-	-	0.04	-

[0033]

[Table 2]

	鋼 No.	化学成分 (%) C	Si	Mn	P	S	Al	Mo	V	Ni	Cr	Cu	Ti	Nb	B
比較鋼	20	0.008*	0.28	1.29	0.011	0.010	0.027	-	-	-	-	-	-	-	-
	21	0.24*	0.29	1.31	0.009	0.008	0.029	-	-	-	-	-	-	-	-
	22	0.11	0.54*	1.30	0.011	0.012	0.025	-	-	-	-	-	-	-	-
	23	0.10	0.30	0.21*	0.012	0.011	0.024	-	-	-	-	-	-	-	-
	24	0.10	0.28	2.15*	0.010	0.009	0.023	-	-	-	-	-	-	-	-
	25	0.11	0.27	1.29	0.029*	0.010	0.025	-	-	-	-	-	-	-	-
	26	0.09	0.29	1.29	0.010	0.030*	0.024	-	-	-	-	-	-	-	-
	27	0.10	0.30	1.28	0.011	0.011	0.115*	-	-	-	-	-	-	-	-

*印はこの発明の範囲外

[0034]
[Table 3]

	試験 No.	鋼 No.	製管仕上温度(℃)	最終熱処理 種類	引張強さ (N/mm2)	落重試験 割れ率(%)	密着へん平
本発明例	1	1	850	焼入れ焼戻し	696	0	○
	2	2	850	焼入れ焼戻し	677	0	○
	3	3	850	焼入れ焼戻し	775	0	○
	4	4	850	焼入れ焼戻し	716	0	○
	5	5	850	焼入れ焼戻し	628	0	○
	6	6	850	焼入れ焼戻し	765	0	○
	7	7	850	焼入れ焼戻し	686	0	○
	8	8	850	焼入れ焼戻し	706	0	○
	9	9	850	焼入れ焼戻し	706	0	○
	10	10	850	焼入れ焼戻し	726	0	○
	11	11	850	焼入れ焼戻し	726	0	○
	12	12	850	焼入れ焼戻し	696	0	○
	13	13	850	焼入れ焼戻し	765	0	○
	14	14	850	焼入れ焼戻し	716	0	○
	15	15	850	焼入れ焼戻し	706	0	○
	16	16	850	焼入れ焼戻し	765	0	○
	17	17	850	焼ならし	657	0	○
	18	18	850	焼なまし	598	0	○
	19	18	850	熱間製管まま	618	0	○
	20	18	800	焼入れ焼戻し	716	0	○
	21	18	700	焼入れまま	740	0	○
	22	18	700	応力除去焼鈍	675	0	○
	23	19	700	焼ならし	650	0	○
	24	19	700	焼なまし	625	0	○
	25	19	700	焼入れまま	756	0	○
	26	19	700	焼入れ焼戻し	725	0	○

[0035]
[Table 4]

	試験 No.	鋼 No.	製管仕上 温度(℃)	最終熱処理 種 類	引張強さ (N/mm2)	落重試験 割れ率(%)	密着 へん平	備 考
比較例	27	20	850	焼入れ焼戻し	520	0	○	強度不足
	28	21	850	焼入れ焼戻し	834	30	×	靭性加工性不足
	29	22	850	焼入れ焼戻し	726	20	×	靭性加工性不足
	30	23	850	焼入れ焼戻し	539	0	○	強度不足
	31	24	850	焼入れ焼戻し	814	30	×	靭性加工性不足
	32	25	850	焼入れ焼戻し	696	20	×	靭性加工性不足
	33	26	850	焼入れ焼戻し	686	20	×	靭性加工性不足
	34	27	850	焼入れ焼戻し	726	30	×	靭性加工性不足
	35	18	700*	熱間製管まま*	736	40	×	靭性加工性不足

(注) *印は本発明の範囲外を示す。

[0036] Also in which component and the process, tensile strength was the high intensity of two or more [590Ns //mm], moreover, the crack of the shoulder after flat does not have further a 0% rate of a crack in a drop weight test, and, as for the example of this invention of trial No.1-26 using this invention steel of steel No.1-19, it had good workability as shown in Table 1 and Table 3.

[0037] On the other hand, the example of a comparison of trial No.27-35 using the comparison steel of steel No.20-27, and this invention steel of steel No.18 as shown in Table 2 and Table 4 Reinforcement lack steel No. -- trial No. using 20 and 23 -- tensile strength 27 and 30 or less [590Ns //mm] by two moreover, steel No. -- 21, 22, and 24- the rate of a crack in a drop weight test is 10% or more, and moreover the crack of the shoulder after adhesion flat occurs, and trial No.28 using 27 and 18, and 29, 31-35 are insufficient of toughness and workability.

[0038]

[Effect of the Invention] The high intensity of claims 1-4 of this invention and the manufacture approach of the steel pipe for high toughness air bags are excellent in the workability and weldability which were suitable for the application of the accumulator for air bags etc. by performing tube manufacturing between heat so that the last finishing temperature may become 750 degrees C or more about the steel which adjusted the chemical entity, and they can obtain high intensity and a high toughness steel pipe.

[0039] The high intensity of claims 5-8 of this invention and the manufacture approach of the steel pipe for high toughness air bags can manufacture the steel pipe for the accumulators of the air bag which was excellent in workability and weldability in the steel which adjusted the chemical entity with the high intensity which was suitable for the property of a policy objective by performing hardening tempering processing with stress relieving annealing, annealing, normalizing, and hardening after tube manufacturing between heat, and high toughness.

[Translation done.]